Chemistry Class 11 NCERT Solutions: Chapter 4 Chemical Bonding and Molecular Structure Part 5

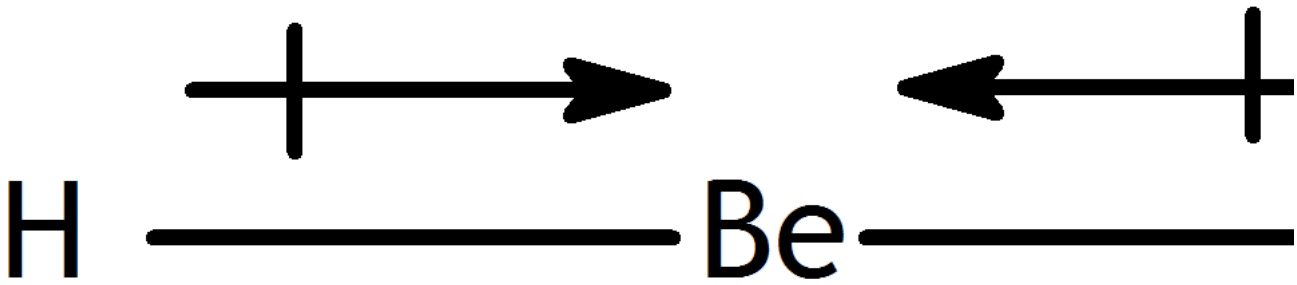
Q: 22. Explain why BeH_2 molecule has a zero dipole moment although the $Be-H$ bonds are polar.

Answer:

The Lewis structure for BeH_2 is as follows:

$H : Be : H$

There is no lone pair at the central atom (Be) and there are two bond pairs. Hence, BeH_2 is of the type AB_2 . It has a linear structure.



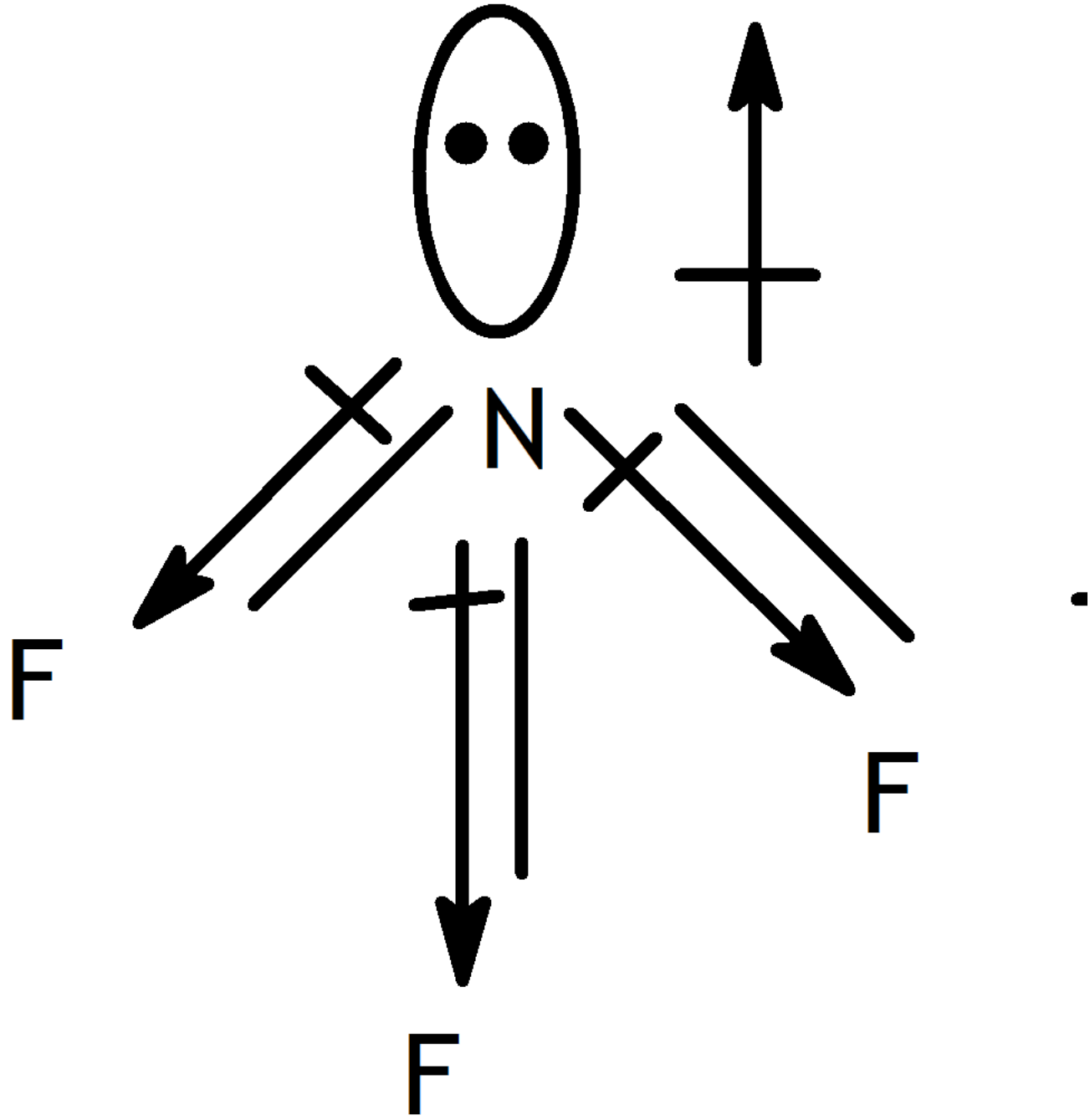
Dipole moments of each $H-Be$ bond are equal and are in opposite directions. Therefore, they nullify each other. Hence, BeH_2 molecule has zero dipole moment.

Q: 23. Which out of NH_3 and NF_3 has higher dipole moment and why?

Answer:

In both molecules i.e.. , NH_3 and NF_3, the central atom (N) has a lone pair electron and there are three bond pairs. Hence, both molecules have a pyramidal shape. Since fluorine is more electronegative than hydrogen, it is expected that the net dipole moment of NF_3 is greater than NH_3. However, the net dipole moment of NH_3 (1.46 D) is greater than that of NF_3 (0.24 D) .

This can be explained on the basis of the directions of the dipole moments of each individual bond in NF_3 and NH_3. These directions can be shown as:



Thus, the resultant moment of the N – H bonds add up to the bond moment of the lone pair (the two being in the same direction) , whereas that of the three N – F bonds partly cancels the moment of the lone pair.

Hence, the net dipole moment of NF_3 is less than that of NH_3.

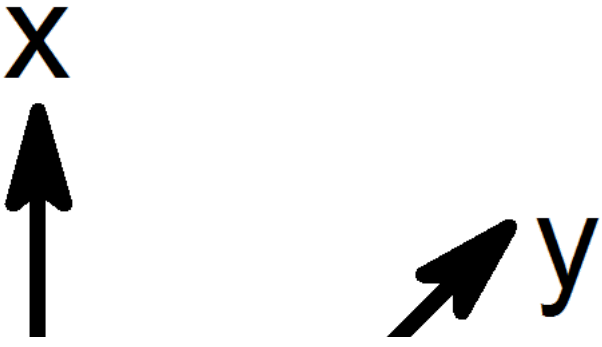
Q: 24. What is meant by hybridization of atomic orbitals? Describe the shapes of sp, sp^2, sp^3 hybrid orbitals.

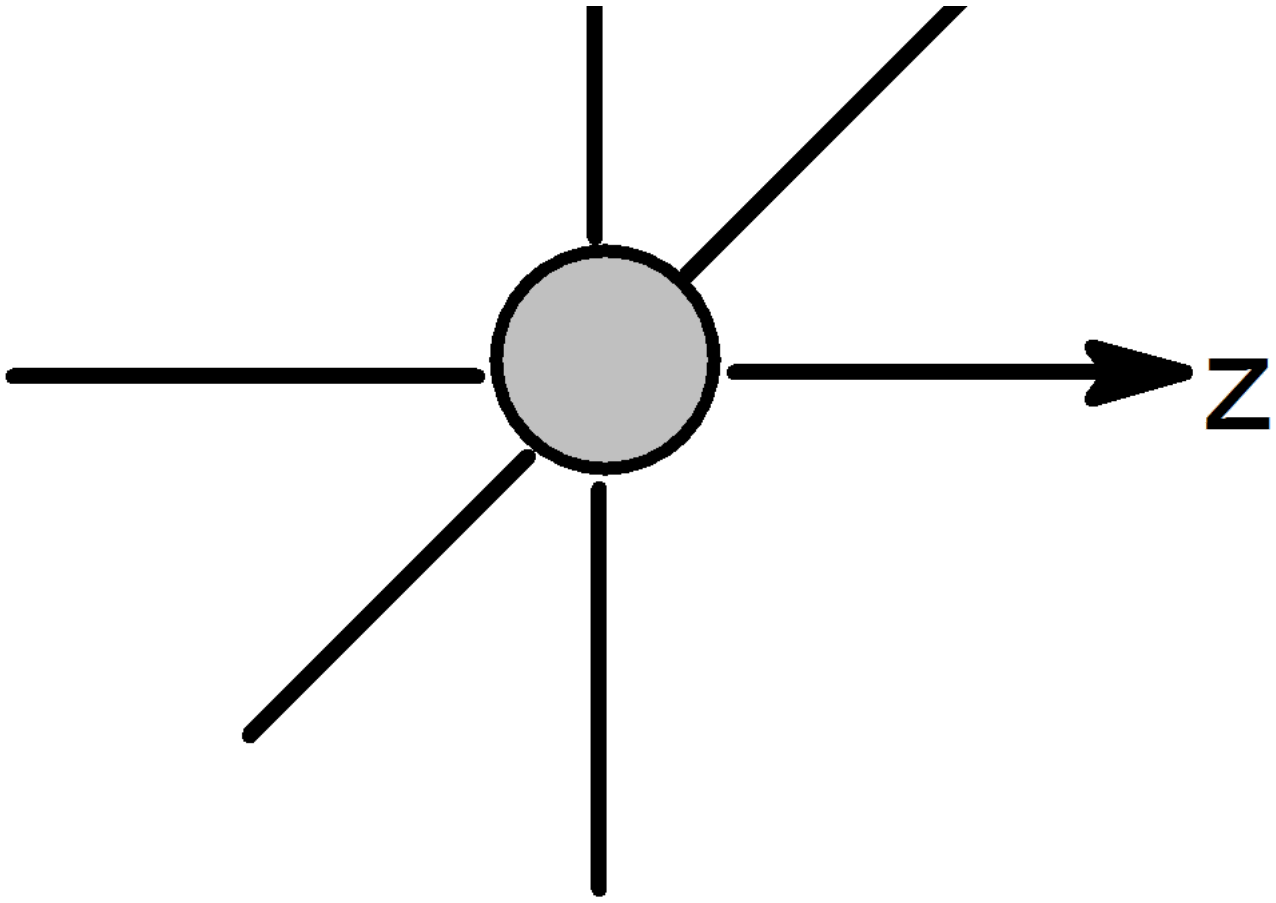
Answer:

Hybridization is defined as an intermixing of a set of atomic orbitals of slightly different energies, thereby forming a new set of orbitals having equivalent energies and shapes. For example, one 2s-orbital hybridizes with two 2p-orbitals of carbon to form three new sp^2 hybrid orbitals.

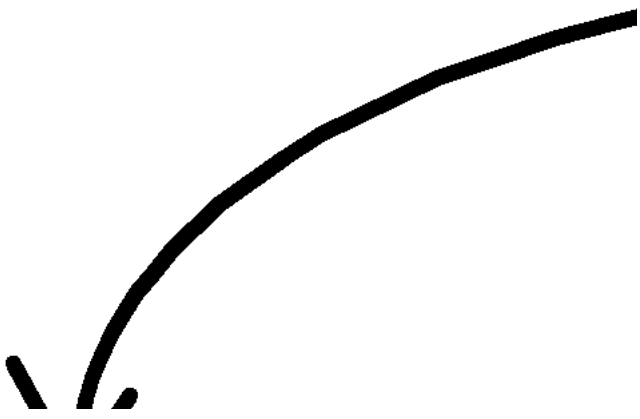
These hybrid orbitals have minimum repulsion between their electron pairs and thus, are more stable. Hybridization helps indicate the geometry of the molecule.

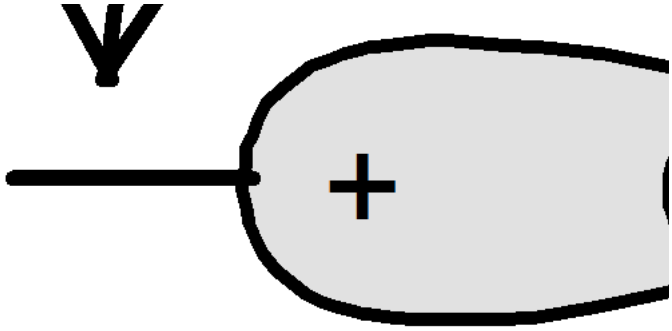
Shape of sp hybrid orbitals: sp hybrid orbitals have a linear shape. They are formed by the intermixing of s and p orbitals as:





s-orbital

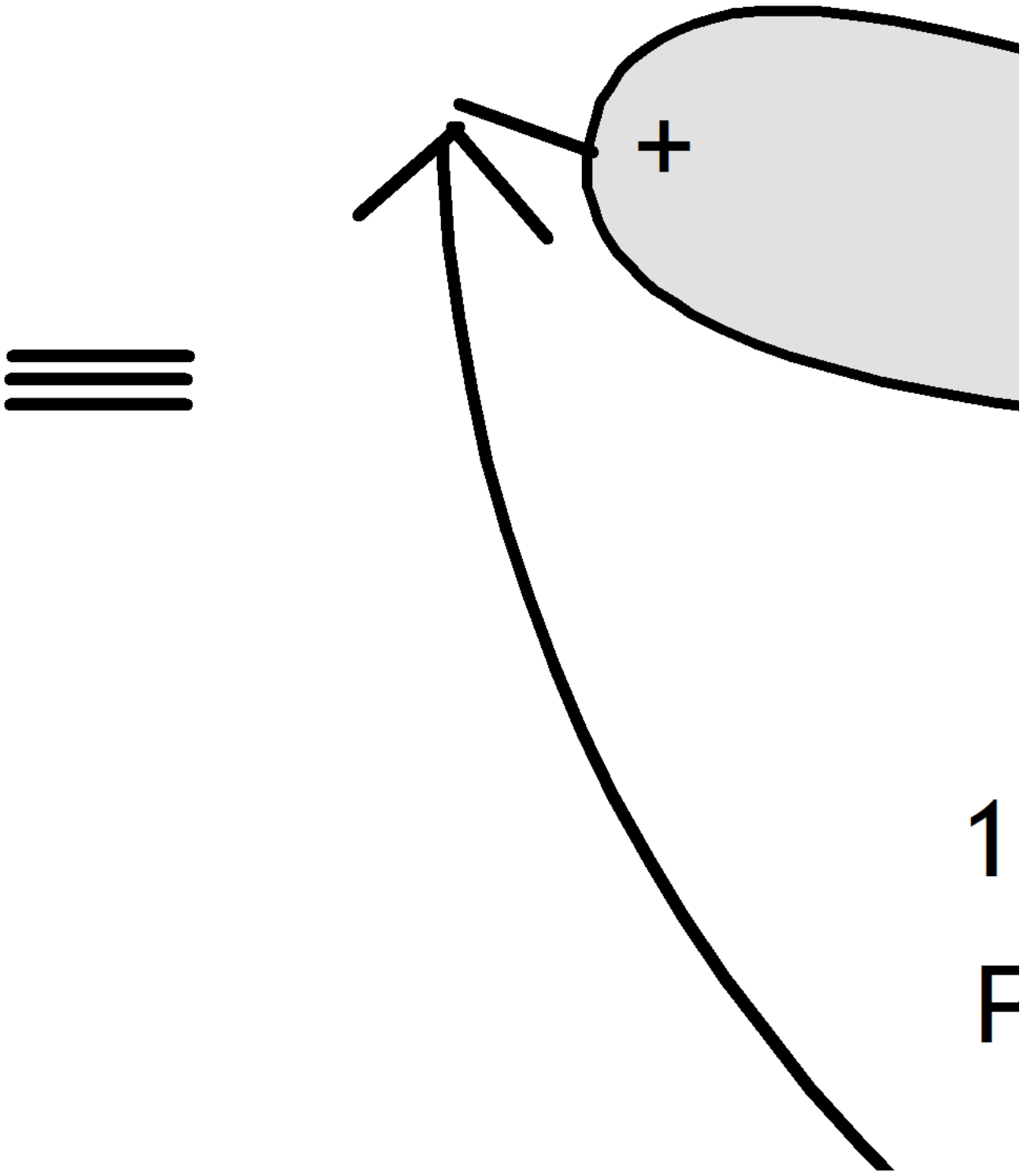


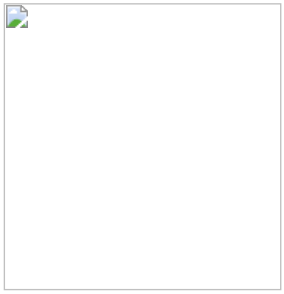


Shape of sp^2 hybrid orbitals:

sp^2 hybrid orbitals are formed as a result of the intermixing of one s-orbital and two 2p- orbitals. The hybrid orbitals are oriented in a trigonal planar arrangement as:

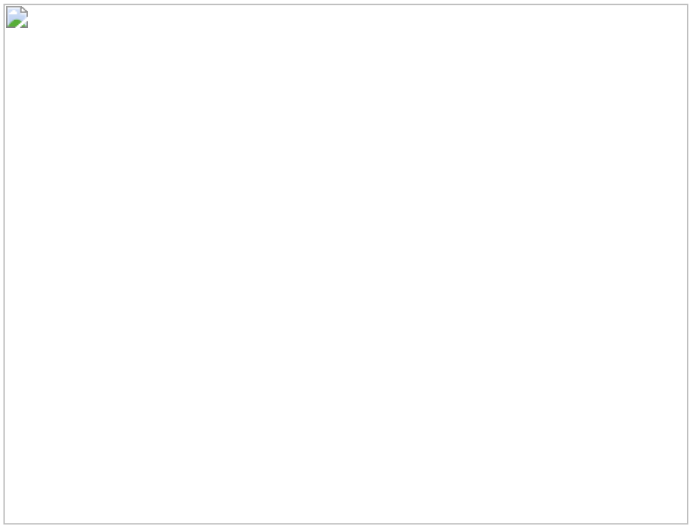
figure:


+
1
F



Four sp^3 hybrid orbitals are formed by intermixing one s-orbital with three p-orbitals. The four sp^3 hybrid orbitals are arranged in the form of a tetrahedron as:

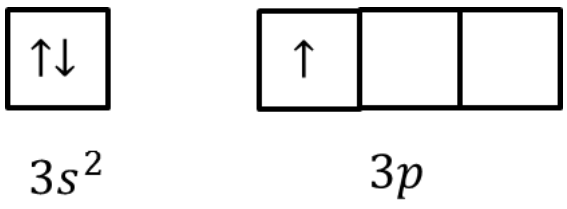
Figure:



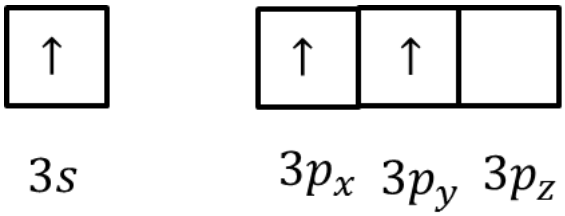
Q: 25. Describe the change in hybridization (if any) of the Al atom in the following reaction. $AlCl_3 + Cl^- \rightarrow AlCl_4^-$

Answer:

The valence orbital picture of aluminium in the ground state can be represented as:



The orbital picture of aluminium in the excited state can be represented as:



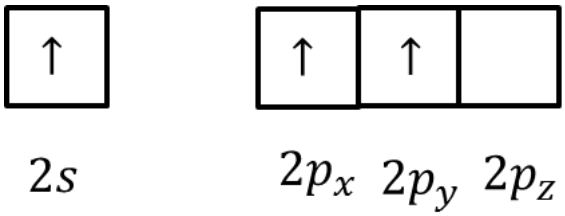
Hence, it undergoes sp^2 hybridization to give a trigonal planar arrangement $(\text{in } AlCl_3)$. To form $AlCl_4^-$, the empty $3p_z$ orbital also gets involved and the hybridization changes from $sp^2 \text{to} sp^3$. As a result, the shape gets changed to tetrahedral.

Q: 26 Is there any change in the hybridisation of B and N atoms as a result of the following reaction?

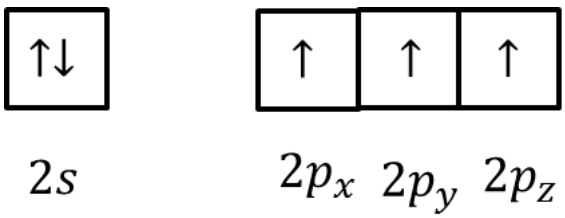
$$BF_3 + NH_3 \rightarrow F_3B.NH_3$$

Answer:

Boron in $BF_3 \text{is} sp^2$ hybridized. The orbital picture of boron in the excited state can be shown as:



Nitrogen atom in NH_3 is sp^3 hybridized. The orbital picture of nitrogen can be represented as:



After the reaction has occurred, an adduct $F_3B{\cdot}NH_3$ is formed as hybridization of 'B' changes to sp^3. However, the hybridization of 'N' remains intact.